Chapter 3

Introduction to Artificial Intelligence (AI)

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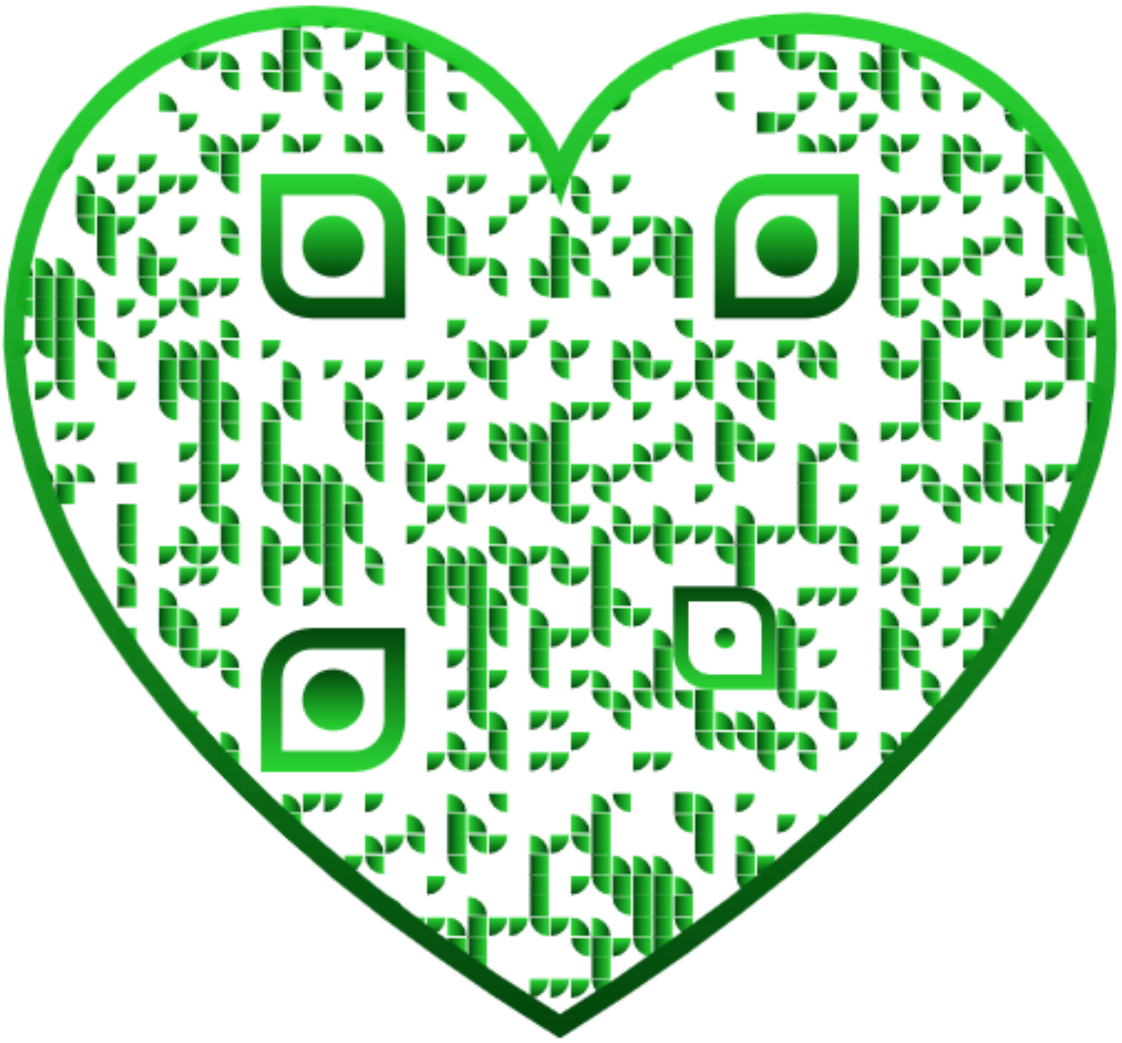

Outline

- Introduction to AI
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  - Health
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- AI tools and platforms
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What is Artificial Intelligence?

- *"is it possible to build a machine that has intelligence, specifically a human level of intelligence?"*

- Artificial Intelligence is
- "The science and engineering of making intelligent machines, especially intelligent computer programs."
- "About ***algorithms*** enabled by constraints exposed by ***representations*** that support ***models*** targeted at ***thinking, perception*** and ***action."***

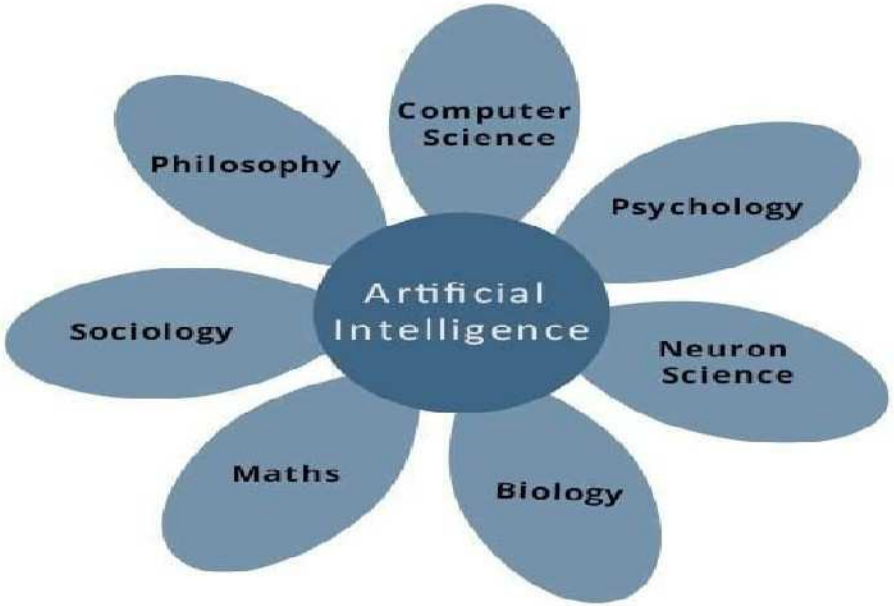
- The theory and development of computer systems able to perform tasks such as visual perception, speech recognition, decision-making, and translation between languages."

What is Artificial Intelligence?

- AI is the creation of a computer program that can learn to think and function on its own, kind of like robots that don't need to be told what to do all the time.
- Most advanced AI systems use machine learning technology to analyze current conditions and learn from experience.

What is Artificial Intelligence?

- AI is a field that originally was founded by computer scientists in the1950s but has since become a multidisciplinary field with applications in nearly every aspect of human life



What is Artificial Intelligence?

Examples of technologies that uses AI

- Machine Learning
- Robotics
- Machine Automation
- Virtual Reality
- Cloud Computing
- Augmented Reality
- Neural Networks
- Big Data
- Internet of Things
- Computer Vision

Machine Learning

- A subset of AI that often uses statistical techniques to give machines the ability to "learn" from data without being given the instructions for how to do so.
- This process is known as “training” a “model” using a learning “algorithm” that progressively improves model performance on a specific task.

Robotics

- Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing.
- These technologies are used to develop machines that can substitute for humans and replicate human actions.

Machine Automation

- Machine automation is any Information Technology (IT) that designed to control the work of machines.

Virtual Reality

- Virtual Reality is the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.

Cloud Computing

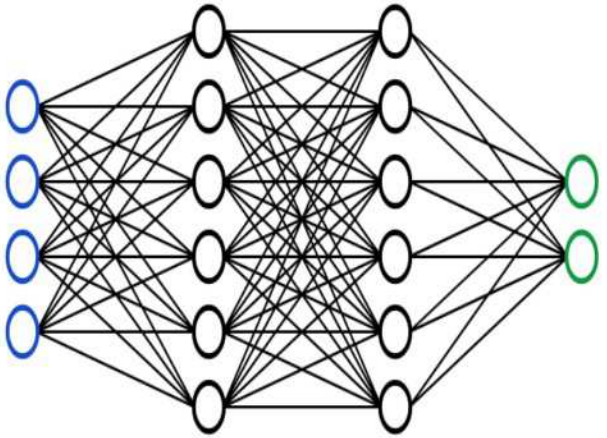
- Cloud Computing the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.
- Cloud Computing involves delivering hosted services over the Internet.
- These services are broadly divided into three categories:
  - Infrastructure-as-a-Service (IaaS),
  - Platform-as-a-Service (PaaS) and
  - Software-as-a-Service (SaaS).

Augmented Reality

- Augmented Reality refers to a technology that superimposes a computer-generated image with sound, text and effects on a user's view of the real world, thus enhancing the user's real world experience.

Neural Networks

- A neural network is a type of machine learning which models itself after the human brain.
- This creates an artificial neural network that via an algorithm allows the computer to learn by incorporating new data.



Big Data/ Internet Of Things(IoT)

- Big Data refers to extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behavior and interactions.
- Internet of Things (IoT) refers to the set of devices and systems that interconnect real-world sensors and actuators to the Internet.

Computer Vision

- **Computer Vision**: Enabling machines to analyze, understand and manipulate images and video.

AI

- The modern AI is based on '*machine learning*' that enables software to perform difficult tasks more effectively by learning through training instead of following sets of rules.
- Knowledge engineering is a core part of AI research. Machines can often act and react like humans only if they have abundant information relating to the world.
- Artificial intelligence must have access to objects, categories, properties and relations between all of them to implement knowledge engineering.

Components of AI system

1. **Applications**: Image recognition, Speech recognition, Chatbots, Natural language generation, and Sentiment analysis.
2. **Types of Models**: Deep learning, Machine learning, and Neural Networks.
3. **Software/Hardware for training and running models**: Graphic Processing Units(GPUs), Parallel processing tools(like Spark), Cloud data storage and computer platforms.
4. **Programming languages for building models**: Pytho TensorFlow, Java, and C/C++, etc.

History of Artificial Intelligence (AI)

- Formally initiated in 1956 and the name **AI** was coined by **John McCarthy**.
- The advent of general purpose computers provided a vehicle for creating artificially intelligent entities.
  - Used for solving general-purpose problems
- Which one is preferred?
  - General purpose problem solving systems
  - Domain specific systems

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Year	Description
1956	The term "artificial intelligence" is coined by John McCharty at a Dartmouth conference and AI is founded as an academic discipline
1956-1974	The golden years of AI enjoy government funding in promising, logic-based problem-solving approaches.
1974-1980	Overly high expectations coupled with the limited capacities of AI programs leads to the first "AI winter", with reduced funding and interest in AI research.
1980-1987	The rise of knowledge-based expert systems brings new successes and a change in the focus of research and funding toward this form ofAI.
1987-1993	The second "AI winter" starts with the sudden collapse of the specialized hardware industry in 1987. The AI hype brings with it negative perceptions by governments and investors, as expert systems show their limitations and prove expensive to update and maintain.

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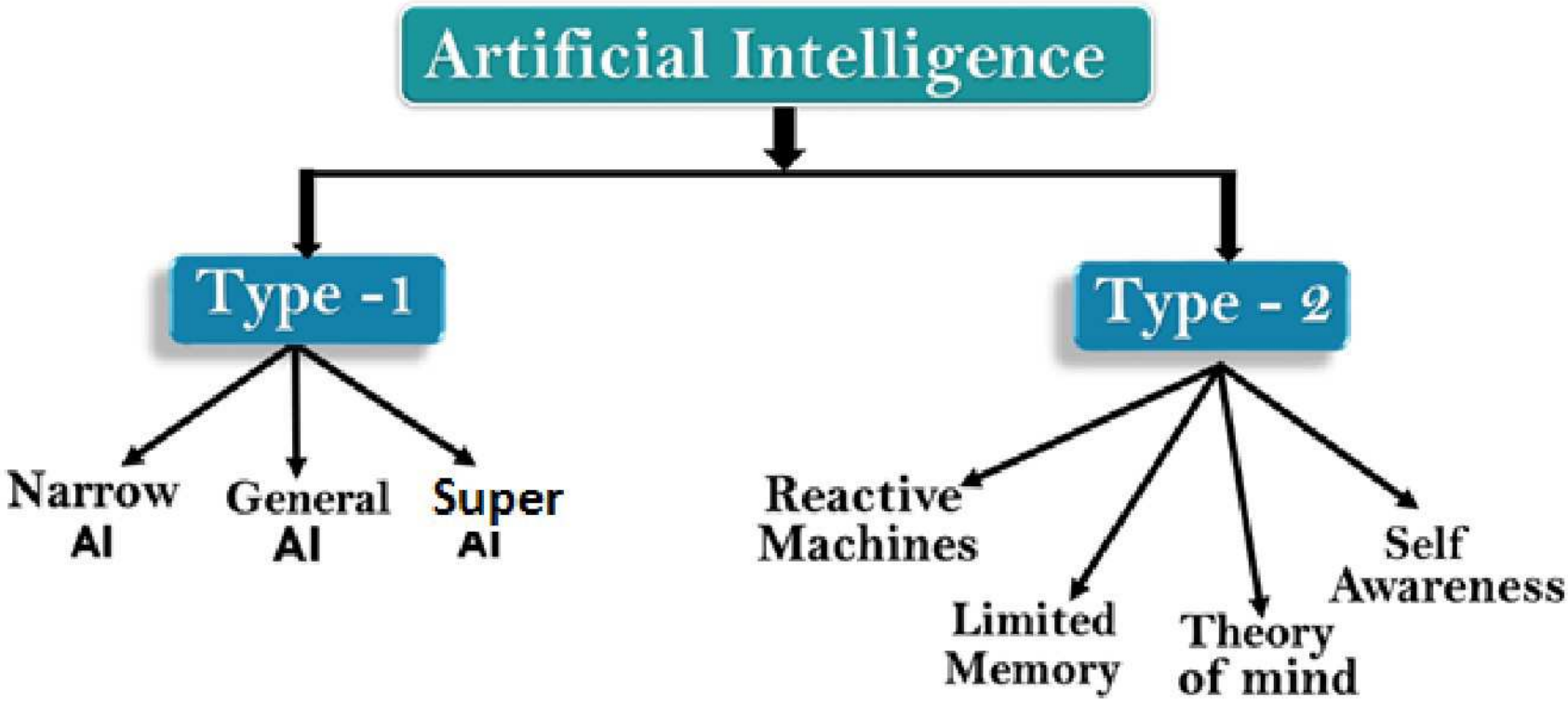
1993-2011	Optimism about AI returns and increases. New successes are marked with the help of increased computational power and AI becomes data-driven.
	In 1997, IBM's DeepBlue beats world champion Gary Kasparov at chess.
	In 2002, Amazon uses automated systems to provide recommendations.
	In 2011, Apple releases Siri and IBM Watson beats two human champions at the TV quiz Jeopardy.
2012-today	Increased availability of data, connectedness and computational power allow for breakthroughs in machine learning, mainly in neural networks and deep learning, heralding a new era of increased funding and optimism about the AI potential.
	In 2012, Google driverless cars navigate autonomously and in 2016 Google AlphaGo beats a world champion in the complicated board game Go.

Types of AI

- Two types of main categorization which are based on capabilities and based on functionally of AI.



Levels of Artificial Intelligence

The different types of AI depend on the level of intelligence embedded into a machine. Based on capability (levels of AI), We can categorize AI into three levels

1. Artificial Narrow Intelligence (Weak AI or Narrow AI)
2. Artificial General Intelligence (General AI or Strong AI)
3. Artificial Super Intelligence (Super AI)

Artificial Narrow Intelligence

- Narrow AI is a type of AI which is able to perform a dedicated task with intelligence.
- The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.
- Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as weak AI.

Artificial Narrow Intelligence

- Narrow AI can fail in unpredictable ways if it goes beyond its limits.
- *Apple Siriis* a good example of Narrow AI, but it operates with a limited pre-defined range of functions.
- IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.

Artificial Narrow Intelligence

Some examples of Narrow AI are

- Playing chess
- Purchasing suggestions on e-commerce site
- Self-driving cars
- Speech recognition, and
- Image recognition.

Artificial General Intelligence

- General AI or Strong AI is a type of intelligence which could perform any intellectual task with efficiency like a human.
- The idea behind the general AI is to make such a system which could be smarter and think like a human by its own.
- Currently, there is no such system exist which could come under general AI and can perform any task as perfect as a human.

Artificial General Intelligence

- Strong AI is a term used to describe a certain mindset of artificial intelligence development.
- Strong AI's goal is to develop artificial intelligence to the point where the machine's intellectual capability is functionally equal to a human's
- The worldwide researchers are now focused on developing machines with General AI.
- As systems with general AI are still under research, and it will take lots of efforts and time to develop such systems.

Artificial Super Intelligence

- **Super AI** is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than human with cognitive properties. It is an outcome of general AI.
- Some key characteristics of strong AI include the ability to think, to reason, solve the puzzle, make judgments, plan, learn, and communicate by its own.
- Super AI is still a hypothetical concept of Artificial Intelligence.
- Development of such systems in real is still world changing task.

Types of AI Based on Functionality

Based on functionality, we have four types of AI, which are described below:

1. Reactive Machines
2. Limited Memory
3. Theory of Mind
4. Self-Awareness

Reactive Machines

- Purely reactive machines are the most basic types of Artificial Intelligence. Such AI systems do not store memories or past experiences for future actions.
- These machines only focus on current scenarios and react on it as per possible best action.
- IBM's Deep Blue system and Google's AlphaGo is an example of reactive machines.

Limited Memory

- Limited memory machines can store past experiences or some data for a short period of time.
- These machines can use stored data for a limited time period only.
- Self-driving cars are one of the best examples of Limited Memory systems.
- These cars can store recent speed of nearby cars, the distance of other cars, speed limit, and other information to navigate the road.

Theory of Mind

- Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans.
- This type of AI machines are still not developed, but researchers are making lots of efforts and improvement for developing such AI machines.
- *Sophia* - the humanoid robot is one example of such effort where a number of young Ethiopians have contributed on the development.

Self-Awareness

- Self-awareness AI is the future of Artificial Intelligence.
- These machines will be super intelligent, and will have their own consciousness, sentiments, and self-awareness.
- These machines will be smarter than human mind.
- Self-Awareness AI does not exist in reality still and it is a hypothetical concept.

Applications of AI

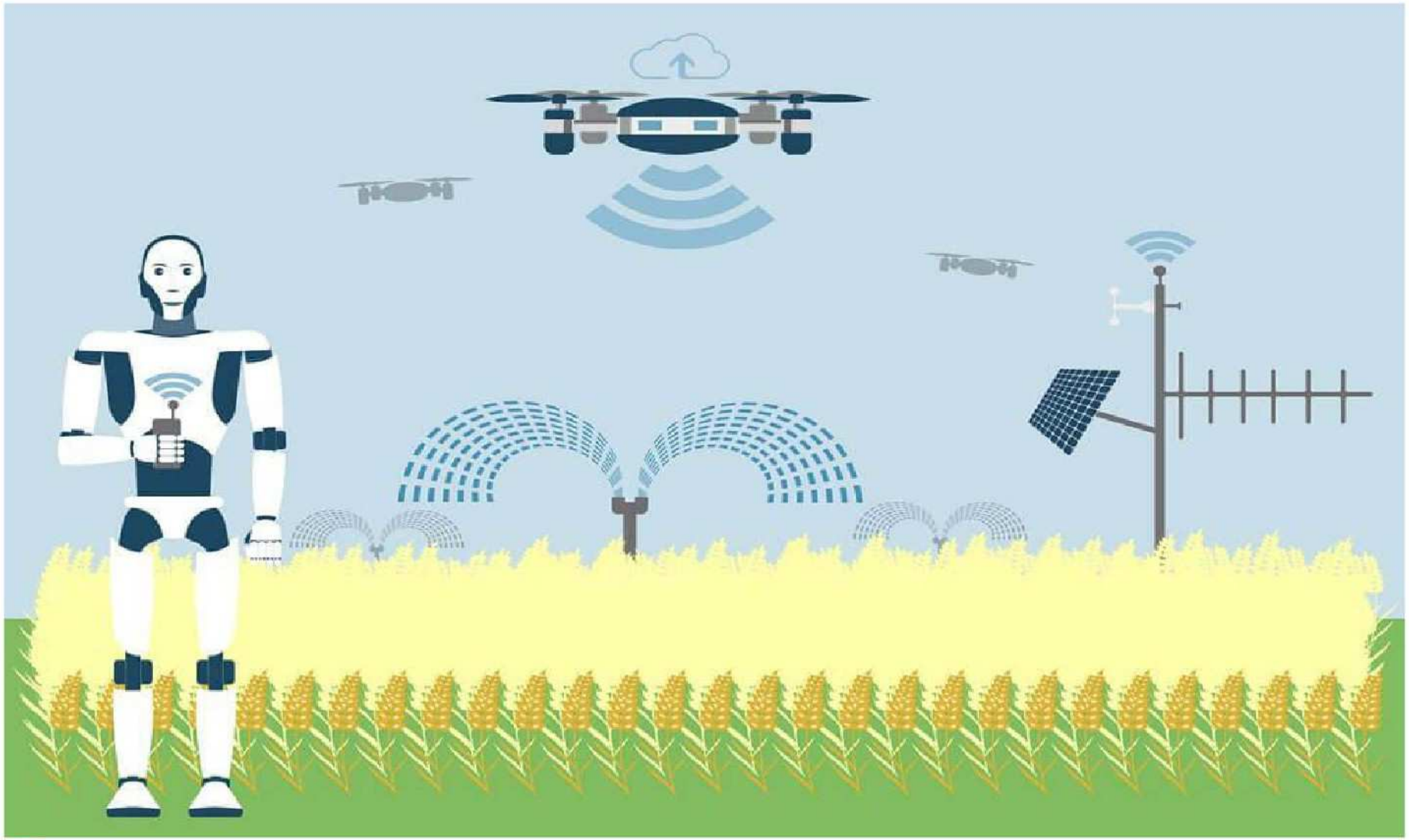
- Currently, AI is being applied across several industries.
- AI is certainly making the work of human beings more efficient.
- The common application areas of Artificial Intelligence in the real world are:
  - Agriculture
  - Health
  - Business (Emerging market)
  - Education

AI in Agriculture

☐ *The agriculture industry is turning to AI technologies to help yield healthier crops, control pests, monitor soil and growing conditions, organize data for farmers, and help with workload.*

- Factors such as climate change, population growth and food security concerns have pushed the agricultural industry into seeking more innovative approaches to protecting and improving crop yield.
- AI-driven technologies are emerging to help improve efficiency and to address challenges facing the agricultural industry including, crop yield, soil health and herbicide-resistance.

AI in Agriculture



AI in Agriculture

- Agricultural robots are poised to become a highly valued application of AI in this sector.
- The most popular applications of AI in agriculture appear to fall into three major categories:

1. **Agricultural Robots**
2. **Crop and Soil Monitoring**
3. **Predictive Analytics**

Agricultural Robots

- Companies are developing and programming autonomous robots to handle essential agricultural tasks such as harvesting crops at a higher volume and faster pace than human laborers.
- Example AI Applications:
  - **See & Spray Robot** - Leverages computer vision to monitor and precisely spray weeds on cotton plants. Precision spraying can help prevent herbicide resistance.
  - **Harvest CROO Robotics** - Crop Harvesting robot in an effort to help address challenges in the labor force.

Crop and Soil Monitoring

- Companies are leveraging computer vision and deep-learning algorithms to process data captured by drones and/or software-based technology to monitor crop and soil health.
- Example AI Applications:
  - **PEAT** - Machine Vision for Diagnosing Pests or Soil Defects.
  - PEAT, a Burline based startup, has developed a deep learning application called ***Plantix*** that reportedly identifies potential defects and nutrient deficiencies in soil.

AI in Predictive Analytics

- Machine learning models are being developed to track and predict various environmental impacts on crop yield such as weather changes.
- Example AI Applications:
  - **aWhere** - Satellites for Weather Prediction and Crop Sustainability - uses machine learning algorithms in connection with satellites to predict weather, analyze crop sustainability and evaluate farms for the presence of diseases and pests.
  - **FarmShots** - Satellites for Monitoring Crop Health and Sustainability - focused on analyzing agricultural data derived from images captured by satellites and drones to detect diseases, pests, and poor plant nutrition on farms.

AI in Health

Companies are applying machine learning to make better and faster diagnoses than humans.

- **IBM Watson** understands natural language and is capable of responding to questions asked of it.
- The system mines patient data and other available data sources to form a hypothesis
- **Chatbots,** a computer program used online to answer questions and assist customers, to help schedule follow-up appointments or aid patients through the billing process, and virtual health assistants that provide basic medical feedback.

AI in Health

Personal Health Virtual Assistant

- People are likely to have their virtual assistant on their smart phone devices.
- Advanced AI algorithms power assistants like Cortana, Google Assistant, Siri.
- When combined with healthcare apps, they will provide massive value to the users.

- Example AI Applications:
  - **Dip.io** - monitor a range of urinary infections. The test detects infections and pregnancy-related complications.
  - **Apple Watch** - generates continuous signal about your heart, activity, and sleep.

AI in Health

Medical Imaging Analysis

- AI in radiology.
  - AI in diagnostic processes
  - examine medical images like X-rays, CT scans, MRIs,

Example AI Applications:

- **IBM Watson** - can provide clinicians with evidence-based treatment options for the cancer patients
- **IDx software** - for diabetic retinopathy detection from eye scans.
- **Viz.ai** was approved to analyze CT scans and notify healthcare providers of potential strokes in patients.

AI in Health

Precision Medicine

- It can predict the health issues the patients might face based on their genes. (DNA)
- AI helps with medical parts machining thus reducing the chances of error in operation.

AI in Health

Healthcare Bots

- Patients will be able to interact with these AI bots on the website through a chat window or via telephone.
- Healthcare bots will be used to schedule appointments with the patient's healthcare provider.
- These bots can help patients with their medication as well.
- They can also improve customer service by offering 24 x 7 support.

AI in Health

Operational applications of AI

- Hospital operations are complex, highly variable and deeply interconnected systems
- This is why it is operationally very challenging to simultaneously deliver high utilization of assets, low wait times for patients, and a large number of available slots for patients seeking an appointment over the next few days.

AI in Business (Emerging market)

- Artificial Intelligence has enormous potential to augment human intelligence and to radically alter how we access products and services, gather information, make products, and interact.
- In emerging markets, AI offers an opportunity to lower costs and barriers to entry for businesses and deliver innovative business models that can advance traditional solutions and reach the underserved.

Business (Emerging Market)

Application of artificial intelligence in business is to:

- **Improve Customer Services**: Use virtual assistant programs to provide real-time support to users.
- **Automate Workloads**: Collect and analyze data from smart sensors, or use machine learning (ML) algorithms to categories work, automatically route service requests,
- **Optimize Logistics**: Use AI powered image recognition tools to monitor and optimize infrastructure, plan transport routes, etc.
- **Increase Manufacturing Output and Efficiency**: Automate production line by integrating industrial robots into the workflow and teaching them to perform labor-intensive tasks.

Business (Emerging Market)

- **Prevent Outages**: Use anomaly detection techniques to identify patterns that are likely to disrupt business, such as an IT outage. Specific AI software may also help to detect and deter security intrusions.
- **Predict Performance**: Use AI applications to determine when you might reach performance goals, such as response time to help desk calls.
- **Predict Behavior**: Use machine learning algorithms to analyse patterns of online behavior.
- **Manage and Analyse Data**: AI can help interpret and mine data more efficiently than ever before and provide meaningful insight into assets, brand, staff or customers.
- **Improve Marketing and Advertising**: AI can help in effectively tracking user behaviour and automate many routine marketing tasks.

AI in Education

- AI technology is adopted in the education sector for various applications
- AI is needed for multilingual translators in education market.
- AI can automate grading, giving educators more time, and can also assess students and adapt to their needs, helping them work at their own pace.
- AI tutors can provide additional support to students, ensuring they stay on track.
- AI could change where and how students learn, perhaps even replacing some teachers.

AI in Education

Examples of AI applications in the Education sector.

- Administrative Tasks Automation
- Smart Content
  - Smart Tutors and Personalization
  - Virtual Lectures and Learning Environment
  - Teachers' Support
  - Students' Communication

AI in Education

Administrative Tasks Automation

- Grading homework,
- evaluating essays and offering value to student responses
- grade system on written responses and essays .
- admission process via chatbot

AI in Education

Smart Content

- robots can create digital content with the same degree of grammatical powers as human in the classroom.
- AI can help digitize textbooks or create customizable learning digital interfaces that apply to students of all age ranges and grades.

Example AI applications include:

- **Cram101** - Uses AI to condense the content in textbooks into a more digestible study guide with chapter summaries, practice tests
- **Netex** - Learning platform allows lecturers and professors to design a digital curriculum and content . Virtual content such as digital lectures and video conferences are also a reality now thanks to AI.

AI in Education

Smart Tutors and Personalization:

- AI guides tutor students based on the difficulties they're having with class material.
- **Carnegie Learning** - Use data from specific students in order to give them feedback and work with them directly.

AI in Education

Virtual Lectures and Learning Environment

- This may replace a lecturer with a robot
- virtual human guides and facilitators that can think, act and react with humans by using gesture recognition technology in a natural way, responding both verbal and nonverbal cues.

AI in Education

Teachers' Support:

- AI provides support for teachers in other ways.
- AI can manage the communication with students.
- For example, a professor can use an AI Chatbot to communicate with students as a teaching assistant all semester without students knowing they were not talking to a human.